An Analysis of Policy Changes in the Canadian Feed Grain Market

A. B. Hickson and C. A. Carter

This paper examines changes in the welfare of Canadian barley and livestock producers attributable to a substantial alteration of Canadian domestic feed grain policy in 1974. Three welfare effects are determined—institutional, destabilization, and risk response. Generally, the analytical results confirmed initial hypotheses, with the exclusion of a positive relationship between price risk and barley production on the Prairies. This positive relationship, theorized to result from the risk reduction effect of yearly stabilized Canadian Wheat Board initial prices, enhanced the welfare benefits of the policy change.

Key words: benefits, destabilization, institutional, policy change, risk response, welfare.

The objective of this paper is to examine the effects of altered policy parameters within a market on the welfare of the market participants. The usual method of solely examining the direct effects of the policy change is extended by considering the indirect effect of altered price risk structures accruable to the institutional change. The case considered is the Canadian feed grain market, which experienced a fundamental change in policy during the mid-1970s. As a prelude to the analysis, it is necessary to provide some background on the characteristics of this market.

Characteristics of the Canadian Feed Grain Market

The most important feed grain in Canada is barley, accounting on average (1974/75–1984/85) for 40% of Canadian requirements. Corn (25%), oats (21%), and lower grades of wheat (14%) meet the balance of Canadian livestock feed requirements. In a regional context, the bulk of barley, oat, and wheat production is concentrated on the Prairies (Manitoba, Saskatchewan, and Alberta), while corn production is predominant in climatically more favourable eastern Canada (Ontario, Quebec, and the Atlantic provinces).[1] The importance of corn production in eastern Canada is a relatively recent phenomenon, with production increasing by 270% over the last two decades.

In terms of regional structure, the Canadian feed grain market may be characterized by a feed grain surplus region, the Prairies, and a deficit region, eastern Canada. The surplus region produces sufficient amounts of feed grain to meet its needs and those in eastern Canada and also allow for exports.

Within this framework there have been several policy alterations which have affected the participants within the market. Key among these policy changes was a substantial redefining of institutional roles within the market, attributable to the adoption of the Domestic Feed Grains Policy (DFP) in 1974. This policy led to a substantial reduction in the role of the Canadian Wheat Board (CWB) in the domestic market. Prior to 1974 the CWB was the sole supplier of feed wheat, oats, and barley interprovincially within Canada, including any transactions between provinces within the Prairie Provinces. The DFP, in reducing the CWB's role, expanded that of the private grain trade, making them equal competitors for sales

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The analysis herein is that of the authors and does not reflect the viewpoint of either of their respective institutions.

[1] For simplicity, British Columbia, a small feed deficit region, has been excluded from the analysis.

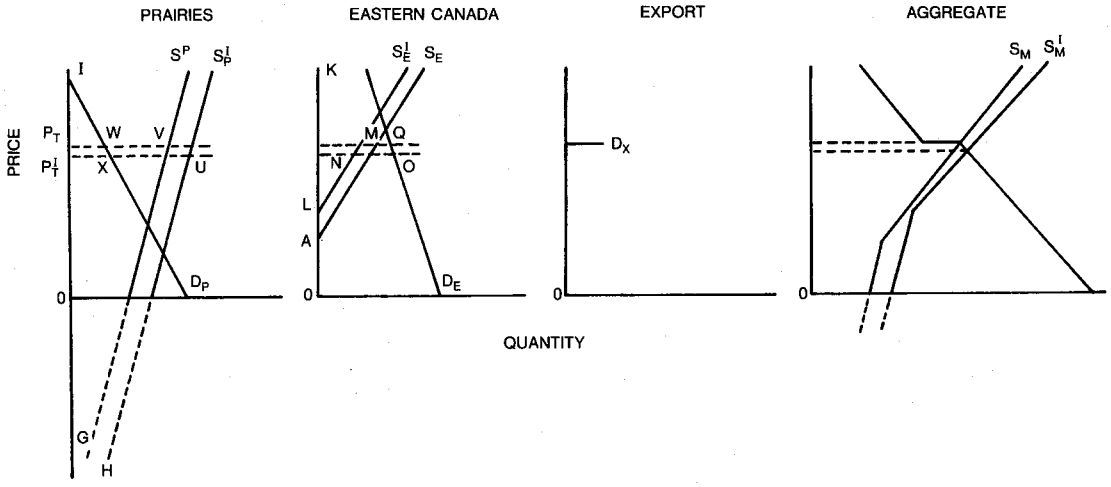

Figure 1. The institutional effect

anywhere within Canada.[2] At the same time the policy enhanced the role of the Winnipeg Commodity Exchange (WCE) from its former mandate of being utilized for price discovery and risk reduction purposes by the private trade on intraprovincial sales, and at times by the CWB to hedge domestic sales, to a more predominant role in domestic price formation.

Why was this policy change undertaken? A key factor in this change was widespread discontent with the effectiveness of feed grain marketing systems, in particular as they impacted barley pricing in the Prairie Provinces during the early 1970s. Several studies (Canada Grains Council) are available which outline the details of this discontent; however, it may be summarized in terms of several phenomena: (*a*) widespread belief that the CWB did not actively pursue sales (export or domestic) of barley, (*b*) an increase of on farm inventories of barley in the Prairie region (from 47 million bushels on average 1964/65–1968/69 to 95 million bushels on average 1969/70–1973/74), and (*c*) cash flow problems for barley producers which resulted in distress sales and illegal "bootleg" sales of barley across interprovincial borders.

In terms of grain production on the Prairies, the result of these phenomena was a declining emphasis on the production of barley. The consequence was that farm management skill and expertise was redirected toward alternative crops. In a sense this was an attitudinal effect which could be expected to have yielded inefficient technological and resource allocation in barley production.

The Effects of the Domestic Feed Grains Policy

The altered direction of Canadian feed grains policy is hypothesized to have manifested itself in three ways: (*a*) via an institutional impact—solely the effect of removing any perceived or real constraints to feed grain production and marketing; (*b*) through an impact on the variability of eastern consumption of Prairie-produced feed grains (this destabilization effect is intertwined closely with changes in feed grain production in eastern Canada); and (*c*) by impacting the variability of prices—a price risk response effect.

In the first case, statistical information as a source of initial testing of the hypothesis is quite scant. However, there is widespread anecdotal evidence available from the period when discussions regarding the policy were underway in the early 1970s. In terms of an economic model of the Canadian feed grains market, this impact is shown in figure 1, where S_P is the supply of feed grains on the Prairies, D_P is the demand for feed grains on the Prairies, S_E is the supply of feed grains in eastern Canada, D_E is the demand for feed grains in eastern Canada, and D_X is the export demand for Canadian feed grains. Assuming that macroeconomic conditions impacting the feed grain market were unchanged after the policy change,

[2] The CWB still had sole jurisdiction over export and domestic human food sales.

Table 1. Consumption of Prairie Produced Barley in Canada

	Post-DFP Policy (Mean 1974/75–1984/85)	Prior to the DFP Policy (Mean 1963/64–1973/74)
Eastern Canada		
Mean consumption[a] (thou. tonnes)	644	700
Coefficient of variation (%)	19	14
Western Canada		
Mean consumption (thou. tonnes)	3,958	3,511
Coefficient of variation (%)	4	34

Source: Statistics Canada, Grain Trade of Canada 22-201.
[a] Based on Feed Freight Assisted shipments.

the institutional change resulted in the Prairie supply curve shifting from S_P to S_P^I. This shift resulted from the adoption of a more efficient production regime in response to the attitudinal change of producers toward feed grain production. For eastern producers the institutional change resulted in a shift backwards from S_E to S_E^I, a less efficient production regime, in response to the expectation of more competition in their market. Depending on the relative size of the shifts, the trade price, P_T, could either rise, fall, or remain the same. In this case it is postulated that the shifts yielded a decline in price, from P_T to P_T^I. The welfare of barley producers and livestock producers changed as follows: (*a*) Prairie barley producers gained $HUP_T^I - GVP_T$; (*b*) Prairie livestock producers gained $IXP_T^I - IWP_T$; (*c*) eastern barley producers lost $AMP_T - LNP_T^I$; (*d*) eastern livestock producers gained $KOP_T^I - KQP_T^I$.

Table 1 shows the impact of the change in DFP on the quantity of Prairie barley demanded in eastern Canada. Prior to the change in policy mean annual consumption (1963/64–1973/74) of Prairie barley marketed in eastern Canada through the commercial system in Canada was 700,000 tonnes compared with 644,000 tonnes after (1974/75–1984/85) the policy change—a decline of 8%. In spite of this decline in consumption, its variability increased by nearly 36%.[3] Comparatively, the consumption of barley within western Canada over the same two periods grew by 13%, while the variability fell by 88%.

Utilizing the expansion of Massell's argument, as formulated by Bieri and Schmitz, the effect of this increased instability is shown in

[3] Part of this increased variability may have been ascribable to more variable eastern Canadian feed grain production. As a test of this hypothesis, the correlation coefficient between feed freight assisted shipments and eastern feed grain production, in corn equivalents was determined. The coefficient was an insignificant −.4.

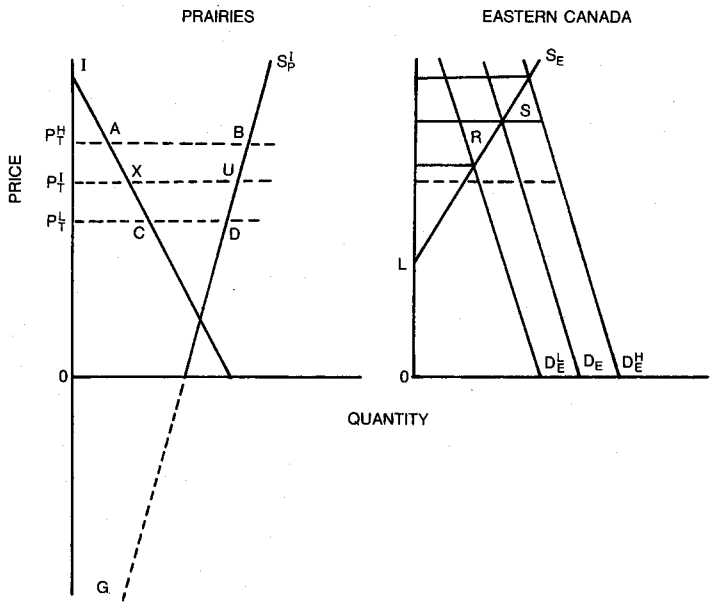

Figure 2. The destabilization effect

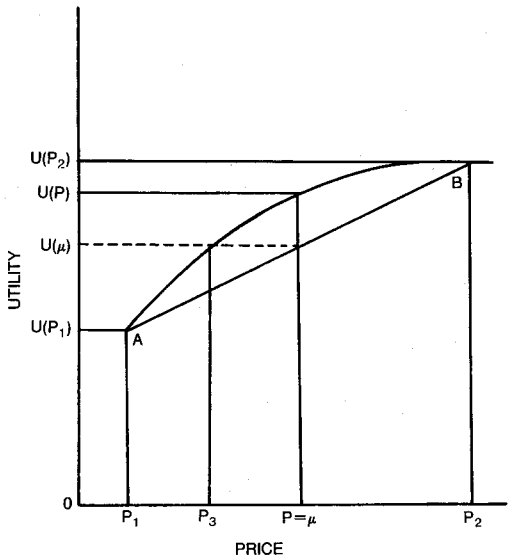

Figure 3. Utility and price

figure 2. Destabilizing eastern demand, D_E, to two equally probable demand curves, D_E^H and D_E^L results in a welfare loss in eastern Canada of $(R + S)/2$. At the same time, Prairie producers gain $\frac{1}{2}(P_T^H BUP_T^I - P_T^I UDP_T^L)$ and Prairie livestock producers gained $\frac{1}{2}(P_T^I XCP_T^L - P_T^I XAP_T^H)$.

Similarly, price variability within the Canadian market increased subsequent to the policy change as shown in table 2, partly as a result of the increasing instability of eastern Canadian demand. Over the ten-year period subsequent to 1974/75, the coefficient of variation for world coarse grain prices, as represented by Chicago Board of Trade corn prices, increased by 20%. Canadian feed grain prices, typified by WCE barley futures, had a 68% increase in variability over the same two periods. What was the impact of this change in price risk for Canadian barley producers and consumers?

The price risk response effect can be developed out of the work of Sandmo. Assuming that output prices are risky, it was shown by Sandmo that the appropriate output level was

$$V'(q) \leqq \mu,$$

where $V'(q)$ is marginal cost, μ is mean of the risky prices, and q is the output level. This level of output can be compared with that in the riskless case by examining utility curve of a risk-averse producer (fig. 3). If the producer has the choice of two equally likely risky prices

Table 2. Canadian Versus World Price Variability

	Mean Price ($Cdn./bushel)	Coefficient of Variation
Post Change in DFP		
WCE barley	2.52	23.0
Chicago corn	2.76	17.5
Prior to Change in DFP		
WCE barley	1.91	13.7
Chicago corn	1.32	14.6

Source: Statistics Canada, Grain Trade of Canada Chicago Board of Trade, Statistical Annual.

P_1 and P_2 or the certain price P, the choice will be the riskless price because the utility at the riskless price is higher for all points along chord AB. To induce production the riskless price would have to fall from P to P_3, equating riskless and risky utility. However, since P_3 is less than P, output at P is greater than output at P_3. Because output at P_3 equals the level of output at μ, output in the riskless case is greater than that in the risky case.

If the relative price-risk level for the producer changes, output will increase, decrease, or remain the same depending on the magnitude of the change in risk and the shape of the utility curve. Assume that producers are risk averters and prices are stabilized at $P = \mu$. The result, due to the lower risk is that the supply curve will shift outward. Conversely, if suppliers are risk averters and prices are less stable, the supply curve would shift inward.

In terms of the Canadian feed grain market, assuming risk-averse behavior, it is hypothesized that the increased risk in prices subsequent to the introduction of the DFP only impacted Prairie producers, yielding a shift in their supply curve inward from S_P^I to S_P^R (fig. 4). For the market participants the effects on welfare were (*a*) Prairie barley producers lost $HUP_T^I - FYP_T^R$, (*b*) Prairie livestock producers lost $IXP_T^I - IZP_T^R$, (*c*) eastern barley producers gained $LJP_T^R - LNP_T^I$, and (*d*) eastern livestock producers lost $KOP_T^I - KEP_T^R$.

Analytical Procedures

The determination of the magnitude (Willig) of the three preceding effects was undertaken utilizing an econometric model of the Canadian barley market. The model consisted of

three sectors—Prairies, eastern Canada, exports, and one national market clearing identity. Each equation contained deflated barley and competitive grain prices along with binary variables to isolate the institutional effect, and other policy changes (quotas, changes in Feed Freight Assistance,[4] and changes in transportation constraints) which could contaminate the results. Consumptive livestock units were included on the demand side of the model to represent changes in regional feed consumption. Price risk was incorporated into the model employing the mean-variance criterion (Tobin). In order to eliminate the impact of yield risk from the model, the supply equations were estimated in terms of seeded areas while demand was based on actual demand, in bushels, converted to an acreage equivalent by dividing by yearly yields.

To assure that the results of the analysis were not biased because of the simultaneous nature of the model, the estimation procedure selected was two-stage least squares. In practice, a variety of analyses were conducted utilizing the original formulation of the model (appendix). Iteratively variables were removed and/or redefined, yielding the following model which was utilized to ascertain the empirical measures of the three effects:[5]

$$(i)\quad S_P = \underset{(9.75)}{15551} + \underset{(.14)}{18527}DPRB8C + \underset{(3.88)}{1367900}DSPRB8C - \underset{(-1.73)}{342760}DPRO8C + \underset{(.64)}{626}DFP - \underset{(-1.38)}{1388}QUOTA$$
$$R^2 = .76,\ d^* = 2.06;$$

$$(ii)\quad D_P = \underset{(-.85)}{-1524.5} - \underset{(-.92)}{82693}DPRBC + \underset{(.95)}{128940}DPROC + \underset{(3.97)}{.701}LNW - \underset{(-.81)}{378.3}DFP$$
$$R^2 = .57,\ d^* = 1.06;$$

$$(iii)\quad S_E = \underset{(6.22)}{976} + \underset{(2.28)}{25633}DPRB8C - \underset{(-3.08)}{47276}DPRO8C - \underset{(-1.06)}{8414}DPRC8C + \underset{(3.53)}{221}DFP$$
$$R^2 = .78,\ d^* = 1.00;$$

$$(iv)\quad D_E = \underset{(-1.38)}{-539} - \underset{(-.72)}{6278}.DPRBC - \underset{(.54)}{4725.4}DPRCC + \underset{(6.09)}{.116}LNE - \underset{(-3.31)}{359}FFA$$
$$R^2 = .77,\ d^* = 1.83;$$

$$(v)\quad D_X = \underset{(-1.81)}{-7162} + \underset{(1.14)}{43900}DPBU + \underset{(3.33)}{.059}LSU - \underset{(-.84)}{611}TRANS$$
$$R^2 = .45,\ d^* = 1.66;$$

$$(vi)\quad S_P + S_E = D_P + D_E + D_X,$$
$$T = 1(1961/62) \text{ to } 24\ (1984/85).$$

Generally, the model conformed with initial expectations, with supply being positively related to price and negatively related to alternative grain prices. While the level of significance, as interpreted by the *t*-statistic, for the own-price variable and Prairie supply was low, this appears to have been the result of the high degree of correlation between *DSPRB*8*C* and *DPRB*8*C*. The exclusion of the former raises the *t*-value for the latter variable to 1.91. In the case of the demand equations, a negative relationship was determined between own price and demand. Competitive grain prices were negatively related to demand. An expansion of the livestock herd yielded an increased demand for barley.

In terms of the variables specifically of concern to this analysis, results generally confirmed initial hypotheses. The change in *DFP* was positively related to barley production on the Prairies. However, the level of significance of this variable, similar to the situation of barley prices to supply on the Prairies, was somewhat low. This low value results from the interrelationship of the price risk variable *DSPRB*8*C* and the policy change variable *DFP*. In the following equation, which excludes the variable *DSPRB*8*C*, the level of significance of *DFP* rises to an acceptable level:

$$S = \underset{(6.98)}{14695} + \underset{(1.91)}{280190}DPRB8C - \underset{(-2.66)}{646550}DPRO8C$$

[4] For details of some of these programs refer to Wilson.

[5] Here d^* is the Durbin-Watson statistic and *t*-statistics are in parentheses.

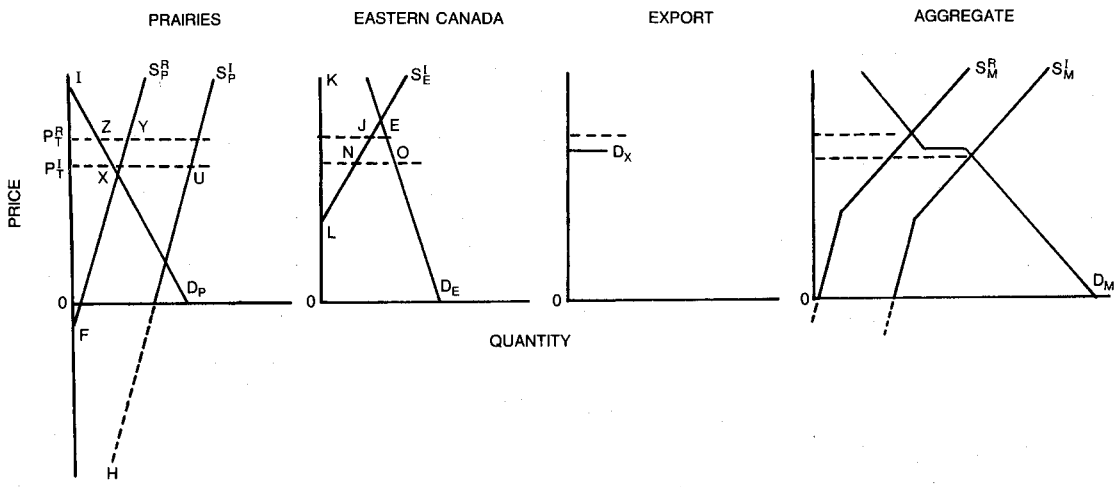

Figure 4. The risk response effect

$$-2546QUOTA + 2821DFP.$$
$$(-1.98) \qquad (2.66)$$

On the Prairies the gains from less-restricted interprovincial movement negatively impacted demand from the livestock sector. Contrary to the initial hypothesis, the change in policy yielded an expansion of barley production in eastern Canada. This expansion is likely accruable to the belief that the opening up of the market would inhibit movement of western grain to eastern feeders. This would present an expanded market opportunity for eastern barley growers. The policy change did not have an impact on eastern livestock producers.

The estimated impact of price risk on barley production on the Prairies was quite different than expected. Higher price risk was positively related to barley production. This appears contradictory to a hypothesis of risk-averse producers. However, this is not such an unusual result if the arguments of Schmitz, Shalit, and Turnovsky are considered. Their argument is based on the premise that if production is considered in terms of a variety of simultaneous activities, one of which is afforded price risk protection, it is feasible that the producer is willing to accept price risk in another aspect of his/her production portfolio. For Prairie barley producers, such a production activity is readily available in terms of wheat production, which is provided a guaranteed floor price through the CWB's initial price.

Welfare Effects

The analytical model was employed in the calculation of the welfare changes due to the three effects. The basis of the procedure was to calculate the appropriate intercepts and price equilibria under each effect. As a starting point,

Table 3. Calculated Prices ($Cdn. per bushel)

	Intercepts				
	Prairie Supply (*H, G, F*)	Prairie Demand (*I*)	Eastern Canadian (*A, L*)	Eastern Canadian (*K*)	Trade Prices
Initial	−43.42	9.15	.99	14.10	3.52
Institutional effect	−46.24	8.77	.27	14.10	2.75
Destabilization					
High demand	−46.24	8.77	.27	15.97	2.83
Low demand	−46.24	8.77	.27	12.27	2.67
Risk response	−47.44	8.77	.27	14.10	2.58

Table 4. Estimated Changes in Welfare (nominal Cdn. thous. dollars/year)

Sector	Market Effect		
	Institutional	Destabilization	Risk Response
Prairie supply	21,866	2	10,657
Prairie demand	2,226	7	1,368
Total prairies	24,092	9	12,025
Eastern Canadian supply	−38	2	−164
Eastern Canadian demand	633	−22	195
Total Eastern Canada	595	−20	31
Total Canada	24,687	−11	12,056

an initialized state prior to the change in policy was derived, then each effect was assessed in relation to the change from the initial state. For this initialization procedure, the exogenous variables in each equation were set equal to their mean values subsequent to 1974/75, exclusive of *DSPRB8C*, which was set equal to its mean for the eleven years prior to the change in policy.

For the institutional effect the calculation involved the setting of the variable *DFP* to 1. The destabilization effect was determined by deriving two equally probable eastern demand curves. These two curves were generated by establishing a 95% confidence interval about the variable *LNE*—the high demand curve calculated utilizing *LNE* = 19,147 and the low demand curve by utilizing *LNE* = 16,743. Welfare with these unstable curves for the market participants was then compared with that following the introduction of the *DFP*. The impact of price risk was determined by setting *DSPRB8C* = .001515, the initial level plus 71% of the change in this variable from the latter eleven years compared with the eleven years immediately prior to the policy change.[6] The price equilibria determined by this procedure are shown in table 3.[7]

Utilizing these price equilibria the respective welfare effects are shown in table 4. The change in the *DFP* resulted in an annual welfare gain of 21.9 million dollars for Prairie barley growers and a welfare gain of 2.2 million dollars for Prairie livestock producers. The gain to livestock producers occurred in spite of the negative direct effect of the policy change on Prairie demand. The resulting price decline from the much larger effect on Prairie supply lowered prices sufficiently to yield benefits to Prairie consumers of barley. Overall, the net gain for the Prairies was $24.1 million per year, about 35% of the average production value. In eastern Canada the policy change resulted in a small loss to growers ($.04 million) and a slight gain for livestock producers ($.6 million), yielding a small net benefit. Overall, for Canada, the policy change resulted in yearly gains for $24.7 million.

The effect of destabilizing eastern Canadian barley demand was small, in spite of the relatively large shifts in livestock numbers. For the Prairies the gain from destabilization was $9,000, of which producers gained only $2,000. In eastern Canada the change in welfare was $20,000, a gain of $2,000 for barley growers and a loss of $22,000 for livestock producers. Overall, the welfare effect for all of Canada was a loss of $11,000.

The effect of the change in price risk also resulted in a positive welfare gain for Canada. Overall, the yearly gain was slightly more than $12.0 million, the bulk of which was received on the Prairies. Contrary to the hypothesized results, these positive benefits resulted from the positive relationship between price risk and Prairie production. Within the regions, the main benefactors were Prairie producers, who gained $10.7 million. Gains for Prairie livestock producers were $1.4 million, while the changes in eastern Canada were a relatively small loss of $.16 million and a gain of $.2 million for growers and consumers, respectively.

Conclusions and Policy Implications

The purpose of this paper was to examine the welfare consequences of policy changes on participants in the Canadian feed grain market. The policy change was the Domestic Feed Grains Policy of 1974. Three aspects of the change were examined: the effect of changing

[6] For the initial, institutional, and destabilization effects *DSPRB8C* was set equal to .001321—the initial level plus (68 − 20)/20 = 71% of the change in level over the 2 periods.

[7] The mean values of the exogeneous variables were

DPRO8C = .023	*DPRC8C* = .038	*DPRCC* = .039
DPBU = .029	*FFA* = .818	*QUOTA* = .546
TRANS = .273	*LNW* = 9,611	*LNE* = 17,928
LSU = 184,220		

the institutional framework in the market, the impact of destabilizing demand in a key constituent of the market, and the associated impacts of altered prices due to the change. The study found that the institutional change yielded substantial welfare benefits to Canada, in particular for Prairie barley growers and livestock producers. In eastern Canada the impact was not as great although livestock producers were beneficiaries of the change. The impact of destabilizing eastern Canadian barley demand was very small, yielding only nominal changes to welfare. The impact of increased price risk yielded a gain in welfare for Canada. This result was contradictory to original expectations, arising primarily because of the beneficial aspects of wheat price stabilization via CWB initial prices on the Prairies.

The foregoing results suggest several important considerations for policy. First, it is evident from the positive relationship of price risk to barley supply on the Prairies that a policy of complete (i.e., removing any elements of the private trade) price stabilization policy is misdirected, simply because it has not been apparent that such policies consider the portfolio aspect of interrelated production activities.

A second implication of the study stems from the relatively small losses experienced by destabilizing eastern Canadian livestock production. While the focus of this study was not directly on this sector, it would appear that these small losses do not support even the administrative expenses of stabilizing this sector.

Finally, the increase in societal welfare attributable solely to the removal of institutional restrictions in the market suggests that less intervention in the market, particularly for other Prairie-produced grains, may yield further societal benefits. While in this case the study is sector specific, it could logically be extended to other economic activities which are under a similar institutional regime.

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Appendix

Definitions

$$S_P = A_0 + A_1 DPRB8C - A_2 DSPRB8C - A_3 DWBPW - A_4 DPRO8C + A_5 DFP - A_6 QUOTA - A_7 LIFT + e_1$$

$$D_P = B_0 - B_1 DRPBC + B_2 DPROC + B_3 DPRWC + B_4 LNW + B_5 DFP + e_2$$

$$S_E = C_0 + C_1 DPRB8C - C_2 DPRO8C - C_3 DPRC8C - C_4 DFP + e_3$$

$$D_E = D_0 - D_1 DPRBC + D_2 DPRCC + D_3 DPROC + D_4 LNE - D_5 FFA + e_4$$

$$D_X = E_0 + E_1 DPBU + E_2 LSU - E_3 TRANS + e_5$$

$$S_P + S_E = D_P + D_E + D_X$$

$$T = 1960/61 \text{ to } 1984/85$$

Variable Definitions

S_P	Supply of feed grains on the Prairies
D_P	Demand for feed grains on the Prairies
S_E	Supply of feed grains in eastern Canada
D_E	Demand for feed grains in eastern Canada
D_X	Export demand for Canadian feed grains
DPRBC	Deflated crop year WCE price of barley
DPRB8C	Deflated (August–March) WCE price of barley
DSPRB8C	Deflated standard deviation of (August–March) WCE price of barley
DPROC	Deflated crop year WCE price of oats
DPRO8C	Deflated (August–March) WCE price of oats
DPRWC	Deflated crop year WCE price of feed wheat
DPRCC	Deflated crop year price of corn in eastern Canada
DPRC8C	Deflated (August–March) price of corn in eastern Canada
DWBPW	Deflated CWB initial price plus the previous year's final payment for wheat

DPBU	Deflated price of barley at Duluth (in $Cdn. per bushel)
LSE	Livestock numbers in eastern Canada in milk cow equivalents
LSW	Livestock numbers on the Prairies in milk cow equivalents
LSU	Pig and cattle numbers in the USSR in milk cow equivalents
DFP	Binary variable for the change in *DFP*, *DFP* = 1 since 1974/75
FFA	Binary variable for the change in Feed Freight Assistance Policy, *FFA* = 1 since 1975/76
QUOTA	Binary variable for the imposition of quotas on feed grains, *QUOTA* = 1 since 1979/80
TRANS	Binary variable for years in which exports were constrained by the transportation system (including strikes and lockouts), *TRANS* = 1 for 1964/65, 1972/73, 1973/74, 1974/75, 1977/78 and 1978/79
LIFT	Binary variable for the introduction of the Lower Inventory for Tomorrow Program *LIFT* = 1 for 1970/71